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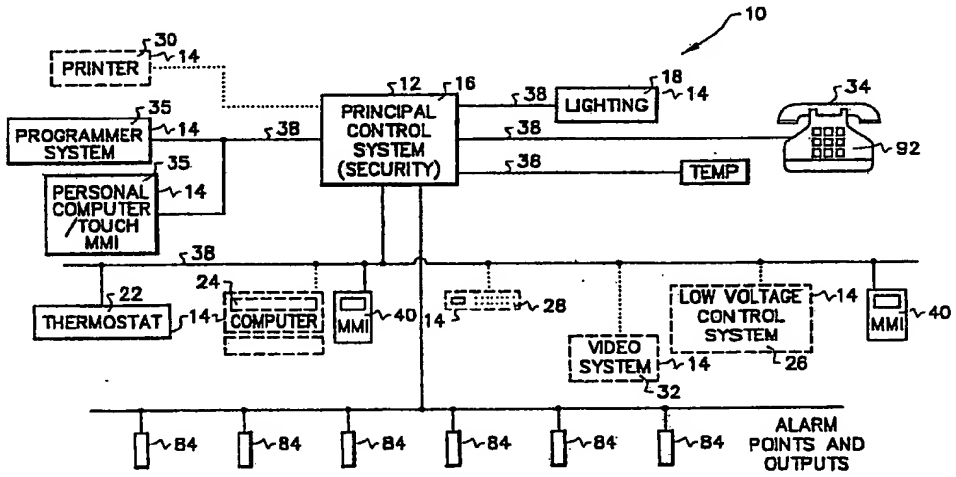
(54) Title: A SYSTEM AND METHOD FOR AUTOMATICALLY CONTROLLING A SPACE

(57) Abstract

A system and method for controlling a space, wherein the space may be a building or buildings, including both residential and nonresidential buildings. A principal control system, which may include a security system, has the ability to control a plurality of control systems, including individual control devices. The principal control system has a main processor means, a memory means and interconnections to a plurality of control systems, and is capable, through the use of these elements, of controlling and integrating the control of these systems. Through a single selection made by an operator, control can be exercised automatically over the plurality of control systems, including the principal control system. Control is accomplished by predetermining and preprogramming a plurality of desired control modes, and storing these control modes in the memory means of the principal control system, such as a security system. Each control mode is designed to incorporate information defining a desired set of conditions which the space is to be controlled to. For example a "leave" mode may define the desired status of a plurality of control systems, such as a security system (e.g. armed), an HVAC system (e.g. setback temperature to a defined level), a lighting system (e.g. turn predefined lights on) as well as others. The modes are used in conjunction with the system to automate the control of a space.



A SYSTEM AND METHOD FOR AUTOMATICALLY CONTROLLING A SPACE

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention includes a system for automatically controlling a space by integrating the control and function of a plurality of control systems and devices utilized within the space, by using a principal control system, such as a security system. These control systems and devices can include an environmental control system, a telecommunications system, a lighting control system, and other electrical control systems including those which control individual electrical or electronic devices such as appliances, audio devices and video devices. This invention also includes a method of automating the control of a space by integrating the control and function of the various control systems utilized, through the execution of preprogrammed control modes which correlate to events having to do with the principal control system, such as security related events, and are executed through the operation of elements of the security system. These preprogrammed control modes contain information for the control of the principal control system, such as the security system, and the control systems and devices, based on the occurrence of certain control events related to the principal control system, such as events related to security, where a security system is the principal control system. More particularly, this invention pertains to building control systems which integrate various control systems and devices of the types described above, such that any one or all of them can be commanded to perform various of the tasks or functions for which they were designed, by the selection of a single, preprogrammed control mode. Therefore, building control requiring a plurality of control systems and devices can be accomplished automatically by a single selection made by an operator. Specifically, this invention relates to a security-event based home automation system of the type described above that includes a plurality of preprogrammed control modes, which

buildings, such as residential or small commercial buildings, because the cost of incorporating the functionality into the programmable controllers in order to make them flexible enough for a variety of configurations, makes these systems too expensive to be commercially practicable in smaller buildings. Also, the control logic and algorithms applicable for large commercial buildings do not typically apply directly to the HVAC, lighting, security and other systems found in residential, small commercial and other buildings, because the equipment used in these systems and use in buildings is quite different than that used in large buildings. Also, the control of large commercial buildings tends to be largely time-based, such that the control algorithms are activated based on a particular time of the day. In instances where event-based activation is utilized, the activation can be based on user input from a central computer station (e.g. configuring an athletic arena in preparation for an upcoming athletic event). Event-based activation has also been used in response to a system-sensed condition, such as a fire alarm, where a programmable controller which senses the alarm condition will report the alarm condition to the central computer station, and the central computer station will execute instructions to the remainder of the system based on the nature of the sensed condition.

In the context of residential, small commercial and other buildings, a multitude of so called automated control systems and methods have been both suggested in the literature and actually implemented. These "automated" control systems have consisted of several general types, including those in which control of various systems is integrated through the use of a central processor or computer, such as a commercially available personal computer, and those which perform the integration through a dedicated central control panel. These systems have not been successful in achieving widespread consumer acceptance for a number of reasons, including limited integration of control systems, cost, and the lack of a simple to operate approach for the non-gadget oriented user.

In the past, automation systems for controlling a space have often not integrated enough of the major systems in residential, small commercial or other

The fact that truly integrated solutions have been very difficult and costly to implement, has led to another general category of solutions which consist essentially of a central control panel. In these systems, a central control panel is provided which permits a user to execute, from the panel, at least some of the functions of various control systems located within the building. Usually, not all of the functionality of the various control systems can be implemented from the central control panel, but only some subset of designated functions. In such systems, the user must actually perform the integration by selecting which of the functions of the various systems he desires to invoke. Each time one of the systems requires a change, an operator must separately consider whether changes to other systems should be implemented as well, and this process must be repeated every time similar is required, which is a very limited form of integration, and not really automation.

One of the significant problems in providing a building automation system which integrates various control systems, is to define a user interface and method of using such a control system which first provides integrated and automated control solutions to an operator in a way which accommodates the operator's requirements with respect to controlling the building. Secondly, the control solution must fit, as nearly as possible, the operator's normal use of the space such that the operator does not view the system as a separate system to be controlled, but rather a system which is implemented as part of the normal activity or simplification of the normal activity to which an operator is accustomed when using the space. This problem has associated with it concepts of "user friendliness", wherein it is necessary to provide a user interface which can be readily understood and utilized without the need for separate training or the need to remember a large amount of operation related instructions. But the problem is also much deeper than that, in that the user interface should also fit in to normal activity, or events, encountered when utilizing the space. For example, consider the implementation of such a system in a home setting. In such a setting, to utilize a user interface which is essentially a central control station, such as a personal computer, activity is required which may be outside the scope of normal home

typically located within a building. The security system has a plurality of direct and bus-based interconnections, for serial digital communication with the various control systems and devices which are to be integrated. The bus-based serial communications comprises a communication protocol, or code, which permits communication to a plurality of devices through a single serial interface.

The invention has a processor means for integrating and coordinating control instructions to the various systems and devices which are connected to the system.

The invention also includes a plurality of preprogrammed instructions located in a memory means which is connected to the processor means, which instructions define a plurality of control modes which are used to integrate the control of the security system and the various control systems and devices which are attached to the system. These modes define the control instructions necessary to accommodate a plurality of different control conditions for the space which is to be controlled. These modes are invoked through the normal operation of the security system. Thus, in the preferred embodiment, the system could be characterized as being principally security-event based, in that security-related events that occur as a result of an operator's normal utilization of the space trigger the control of both the security system and the other control systems and devices located within the space. These preprogrammed instructions can be stored in the memory means by connecting a programming device to the system directly and transferring program instructions into the memory means for storage, or by remote access via a telecommunications interface, such as a modem.

The security system can be operated via a plurality of input devices, including a security panel, or panels located in one or more locations within the home, telephones located within the home via a voice module, and remotely from a telephone or similar telecommunications device also via the voice module.

A principal object of this invention is to provide a system which integrates and automates the control systems typically found within a building. A second object of the invention is to provide an automation system for controlling a space, which can be

Figure 3a is a more detailed functional block diagram of the security system of Figure 2.

Figure 3b is a continuation of the functional block diagram of Figure 3a.

Figure 4 is a front view of the home security panel.

Figure 5 is a block diagram of a home security panel showing its interconnection to the control panel.

Figure 6 is a floor plan of a sample house using the inventive system.

Figure 7 is a matrix of modes, statuses and points within the house of Figure 6.

Figure 8 is a flow chart of the method of operation of the inventive system.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to Figure 1, an automation system 10 for automatically controlling a space is illustrated. In a preferred embodiment of the invention as described herein, automation system 10 would be particularly suitable for automatically controlling a building, such as a small commercial building, a home, or a similar building. Automation system 10 comprises a principal control system 12 connected to a plurality of control systems 14. In a preferred embodiment of the invention, principal control system 12 is security system 16 electrically connected to plurality of control systems 14, including lighting system 18 and thermostat 22. Other control systems 14 could be electrically connected to security system 16, including personal computer system 24, low voltage control system 26, entertainment system 28, printer system 30, and video system 32, as well as any number of other systems which might be located in or near the building, and including systems which could be remote from the building and interconnected via telecommunications device 34 or otherwise. In a preferred embodiment of the invention, a control system 14 which could be remote from security system 16, could include programming system 35. The following describes security system 16, plurality of control devices 14 and their interconnection.

Control point processor 54 is capable of receiving a plurality of inputs from control points 84, and transmitting the input information to main processor 50 via address line 48 and data line 49.

As described herein, in addition to processor means 44, control panel 36 also comprises memory means 46. In a preferred embodiment, memory means 46 comprises a combination including Electrically Programmable Read Only Memory (EPROM) 64, Random Access Memory (RAM) 66 and Electrically Erasable Programmable Read Only Memory (EEPROM) 68. Particularly, memory means 46 is capable of storing a preprogrammed set of instructions 70 relating to a set of control conditions or modes desired within the building, and providing these instructions to main processor 50 via address line 48 and data line 49 in response to a request made by an operator.

Referring now to Figures 2 and 3a, having described the elements of control panel 36, automation system 10 also comprises plurality of interconnections 38 to provide for the connection of principal control system 12 and plurality of control systems 14. In a preferred embodiment, this arrangement comprises security system 16 interconnected with control systems 14, such as lighting system 18, voice access system 20 and thermostat 22, via lighting interconnection 74, voice access interconnection 76 bus interconnection 78, respectively. In a preferred embodiment, these interconnections are all accomplished via digital data interfaces.

Referring now to Figure 3a, lighting interconnection 74 is accomplished via a direct RS232 serial interface to main processor 50. Voice access interconnection 76 to main processor 50 is accomplished via address line 48 and data line 49, and thermostat interconnection is accomplished via a data bus using an RS485 serial interface to data bus processor 52, which is in turn connected via a serial interface to main processor 50.

Referring now to Figure 4, security system 16 also comprises HSP 40, which is now further described. HSP 40 is a man-machine interface (MMI). In a preferred embodiment, the MMI comprises a touch key-pad 80 and a display 82, such as a

Lighting system 18 is a commercially available system sold by X-10 Powerhouse, as Model No. CP290, and is of a type known to those of ordinary skill in the art. Lighting system 18 uses powerline carrier based signal to automatically switch power on or off to control modules, which can be used in conjunction with lights and other electrical appliances and devices. Its use is not limited to lighting devices only. For instance, lighting system 18 could be used to control appliances such as a coffee maker, electric heater, or other devices which can be operated by on/off switching of AC power. Lighting system 18 is connected to security system 16, using lighting interconnection 74, and is capable of receiving a control signal from security system 16. In a preferred embodiment, lighting system 18 is capable of operation independently of security system 16, in the event that security system 16 ceases to provide control signals as described above.

Voice access system 20 is shown and described in Figures 1 and 2. Voice access system 20 incorporates speech synthesizer 90. Speech synthesizer 90 is combined with components known to those of ordinary skill in the art to produce a system which allows an operator to operate security system 16 remotely through the use of telecommunications device 34, such as a touch tone telephone 34. Voice access system 20 allows an operator to operate a security system 16 remotely, by selecting the same modes that are available to the operator through HSP 40. Touch tone telephone 34 can be a telephone located in the space to be controlled, such as one or more of touch tone telephones located in a building, or, touch tone telephone 34 may be remote from the space which is to be controlled, such as a cellular telephone or telephone located in another building. Voice access module 20 also allows an operator to receive certain information from various control systems 14 which are adapted to communicate information concerning their status. Voice access system 20 also incorporates security features which require that an operator enter certain passcodes before being able to effect changes to security system 16. In particular, passcode entry is required whenever the level of security is to be reduced. Voice access system 20 also incorporates a voice-based menu scheme wherein voice access

Referring now to Figures 1, 2, 3a and 3b, programmer system 35 may be utilized to define modes for security system 16, by programming instructions related to the control of security system 16 and various of control systems 14, into memory means 46. Programmer system comprises a computer, such as a computer which is capable of executing Disk Operating System (DOS) such as are known to those of ordinary skill in the art, and a program for defining a particular mode. The program converts certain menu options related to control conditions of the various elements of automation system 10 to define a particular mode. A plurality of modes can be defined by the program and can be transferred to memory means 46 using a single step, or series of steps.

Having described security system 16 and control systems 14, including lighting control system 18, voice access system 20, thermostat system 22 and programmer system 35, the functions of these systems together is further described hereinbelow.

Prior to utilization of security system 16, security system 16 must have preprogrammed instructions 70 defining the control instructions necessary to operate security system 16 and control systems 14, stored in memory means 46. These preprogrammed instructions 70 define certain modes as described herein. This can be accomplished by connecting programmer system 35 to security system 16 via a modem, or by connecting programmer system 36 directly to security system 16 through a serial digital interface, such as an RS232 serial interface. Once programmer system 35 has been connected to security system 16, preprogrammed instructions 70 can be stored in memory means 46. Once this has been accomplished, security system 16 is available for use by an operator.

In order to operate security system 16, an operator must make a selection of a mode. This can be accomplished in one of several ways. First, selection of a mode can be accomplished by utilizing HSP 40. Secondly, a touch-tone telephone 92 located within the building can be utilized. Also, a touch-tone telephone 92 located outside of the space to be controlled can be used.

100, security system 16, places a call through modem 100 using the telephone number which has been preprogrammed into memory means 46. In this way, it can be ensured that access for the purpose of programming security system 16 can only come from authorized locations.

This presents a problem, however, during the initial programming of memory means 46, as described herein, because one of the items of information that must be programmed in is the preprogrammed instruction 70 related to the call-back telephone number. Therefore, initial programming would not normally be possible from a remote location. However, security system 16 also incorporates in memory means 46, an authorization code related to the call-back feature. The code has associated with it a set of preprogrammed instructions 70, which instruct security system 16 to accept telephone calls from remote devices for a predetermined time period, such as fifteen minutes. Therefore, by entering a predefined passcode at HSP 40, an operator can cause main processor 50 to retrieve preprogrammed instructions 70 from memory means 46, directing that security system 16 disable its normal security provisions as described above, and accept a telephone call through modem 100 directly, without requiring that security system 16 do a call-back to initiate communication.

Returning now to Figure 6, there shown is a sample building incorporating a home automation system of the present invention. House 1000 is made up of rooms 1001, 1002 and 1003. House 1000 also has four doors 1015a through 1015d, and three windows, 1020a through 1020c. Associated with each door and window is a sensor 1025 for monitoring the position of the door or window. Also included in the house are thermostats 1035a and through 1035c, home security panels (HSP) 1030a and 1030b, security alarm control panel 1031 and lights 1040a through 1040j. House 1000 also has a swimming pool 1100. Lastly, iron 1050 is connected to relay outlet 1055, which is controlled by control panel 1031.

Control panel 1031, as described before, controls the home security, lighting, appliance and thermostat controls, although the lighting control system and the thermostat control system can operate independently of control panel 1031. Changes

The iron 1050 may be turned off by controlling the relay in relay outlet 1055 thus insuring that the iron is not left on after the occupant departs.

Thermostat program causes the thermostat to go to a user selected setpoint when a particular mode is entered. Thermostat setpoint for the LEAVE mode may be different from the thermostat setpoint for the WAKE mode. The security panel may request from the operator a return time so that the thermostat setpoint can be adjusted to the anticipated return time of an occupant.

In the WAKE mode, windows 1, 2, and 3 remain armed while doors 1, 2, 3 and 4 are disarmed. Lights 1, 2, 6, 8, 9 and 10 are turned off, while lights 3, 4, 5 and 7 are turned on. Again, thermostats 1, 2 and 3 may be set to preprogrammed setpoints. Note that the status of doors 1, 2, 3 and 4 has not changed over the previous period.

The mode entitled POOL PARTY may be useful where the owner of House 1000 desires to have a party around the swimming pool. In this instance, all windows remain armed, as do doors 2 and 3. However, doors 1 and 4 are placed on watch to allow access to the pool through the house, while providing only local indication of the opening of the point. Lights 1, 3, 5, 7, 9 and 10 are forced on, and providing lighting to and at the swimming pool. Note that lights 2 and 4 remain in the same status that they were in prior to entry of the mode POOL PARTY, so that other occupants of the house are unaffected by a change in the mode. Lights 6 and 8 are forced off to indicate that no one should enter room 1003. In addition, the thermostat setpoints are unchanged, because it may remain desirable to keep the already-reached setpoint.

The mode entitled WORK arms all access points, and programs lights 1 and 3 to turn on at a preselected time. This allows the house to appear occupied even though the owner of House 1000 may not have yet arrived back at home. Lights 2, 4, 5, 6, 7, 8, 9 and 10 are forced off to save energy. Thermostats 1, 2 and 3 may enter a programmed setback mode in which temperature during the heating season is

returns to block 1210. If a valid passcode is entered, the process moves to block 1220. If no decrease in security occurs, the process goes directly from block 1215 to block 1220.

At decision block 1220, the control panel asks whether the lighting system requires any changes based on the mode entered. If the answer is yes, block 1225 indicates that the control panel makes the required changes for the selected mode and returns to the process at block 1230. If no lighting system changes are required, then the process continues on to block 1230 unimpeded.

At block 1230, the control panel determines whether the mode entered requires any thermostat changes. If thermostat changes are required, they are initiated at block 1235. Note that this may mean that a program is initiated which causes a temperature change to the initial mode change, coupled with a later temperature change in anticipation of reoccupancy of the house. The process then returns to decision block 1240. If no thermostat changes are required, the process moves on to decision block 1240 unimpeded.

At block 1240 the control panel asks whether security system changes are required. If the answer is yes, the control panel makes the required changes at block 1245. If the answer is no, then the process returns to block 1215, delays for a predetermined time, and starts again.

The foregoing has been a description of a novel and nonobvious system for automating the control of a space. The inventors do not intend for this description to be limiting, but instead describe their invention through the following claims.

transmission of control instructions to the control system identified in said preprogrammed set of instructions corresponding to the desired control condition; and

executing said preprogrammed set of instructions within the security system corresponding to the desired control condition.

5. The method of claim 4, further comprising the step of:

communicating information regarding the status of the security system and the control system to a device which can be interrogated by an operator.

6. A system for automatically controlling a space comprising:

a principal control system having a main processor means, a memory means and a plurality of interconnections, said principal control system controlling at least one set of conditions within a space such as security conditions, lighting conditions and temperature conditions, said principal control system also adapted to issue control instructions to a plurality of devices controlling other conditions within the space;

at least one control system, said at least one control system connected to and capable of receiving the control instructions from said principal control system through the interconnections, said control system controlling at least one set of conditions within the space not controlled by said principal control system; and

at least one control mode comprising a set of preprogrammed instruction stored within the memory means, said control mode defining control parameters for the conditions controlled by said principal control system and said control system, wherein an operator may select the control mode and cause preprogrammed instructions in the memory means associated with said control mode to be communicated to the processor means and processor means takes the preprogrammed instructions and issues corresponding control instructions to said principal control system and said control system, thereby causing them to execute the conditions for the space defined by said control mode.

14. The system of claim 13 wherein the interconnection connecting said thermostat and said security system is a data bus.

15. The system of claim 14 wherein the data bus utilizes 4 bit to 8 bit decoding/encoding, such that the processor means of said security system and a thermostat processor means in the thermostat can process 8 bit code words while communications between the devices is accomplished by transmission of 4 bit data words over the data bus.

16. The system of claim 12 wherein said control system is a lighting control system.

17. The system of claim 6, further comprising:

a programmer system for programming the preprogrammed instructions associated with said control modes into the memory means, and detachably interconnected to said principal control system, such that the programmer system can be utilized for programming the memory means and then removed when its use is not required.

18. The system of claim 17 wherein the programmer system comprises a personal computer.

19. A system for automatically controlling a space, comprising:

a security system having a main processor means, a memory means and a plurality of interconnections, said security system controlling the security conditions comprising parameters for a plurality of security related devices, said security system also adapted to issue control instructions to a plurality of devices controlling other conditions within the space;

a plurality of control systems, said control systems connected to and capable of receiving the control instructions from said principal control system

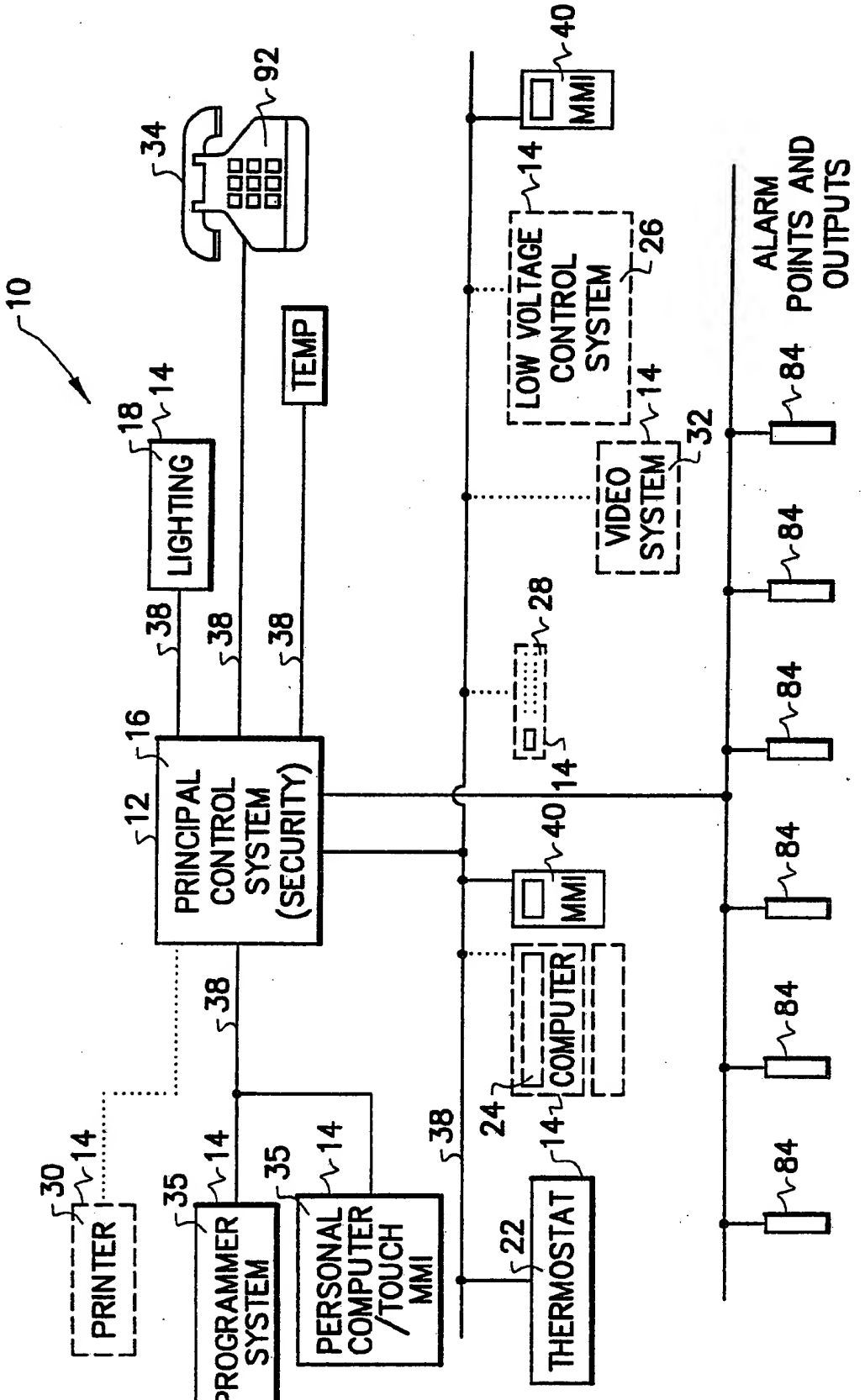
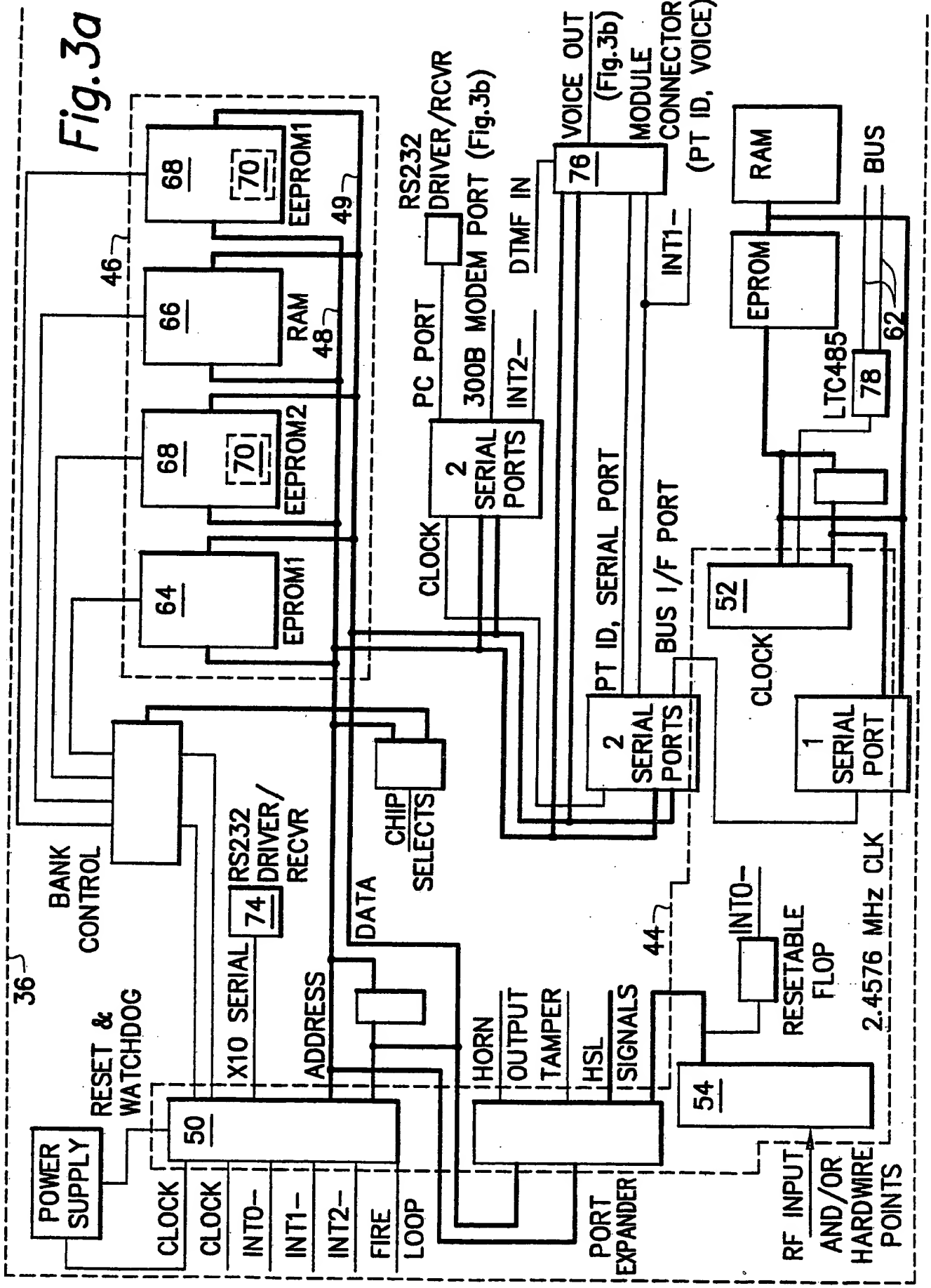

10
PRINCIPAL CONTROL SYSTEM (SECURITY)
12
16
LIGHTING
18
TEMP
34
92
LOW VOLTAGE CONTROL SYSTEM
26
VIDEO SYSTEM
32
MMI
40
COMPUTER
24
THERMOSTAT
22
PROGRAMMER SYSTEM
35
PERSONAL COMPUTER /TOUCH MMI
PRINTER
30
ALARM POINTS AND OUTPUTS
84
28
14
38

Fig. 1

Fig. 3a


36
POWER SUPPLY
RESET & WATCHDOG
CLOCK
CLOCK
INT0-
INT1-
INT2-
FIRE
LOOP
50
BANK CONTROL
X10 SERIAL
74
RS232 DRIVER/ RECVR
ADDRESS
DATA
CHIP SELECTS
68
70
EEPROM1
46
49
66
RAM
48
68
70
EEPROM2
64
EPROM1
RS232 DRIVER/RCVR
PC PORT
CLOCK
2 SERIAL PORTS
300B MODEM PORT (Fig.3b)
INT2-
DTMF IN
VOICE OUT (Fig.3b)
76
MODULE CONNECTOR (PT ID, VOICE)
PT ID, SERIAL PORT
2 SERIAL PORTS
BUS I/F PORT
INT1-
HORN
OUTPUT
TAMPER
HSL
SIGNALS
PORT EXPANDER
44
54
INT0-
RESETABLE FLOP
RF INPUT
AND/OR HARDWIRE POINTS
2.4576 MHz CLK
RAM
EPROM
62
BUS
LTC485
78
52
CLOCK
1 SERIAL PORT

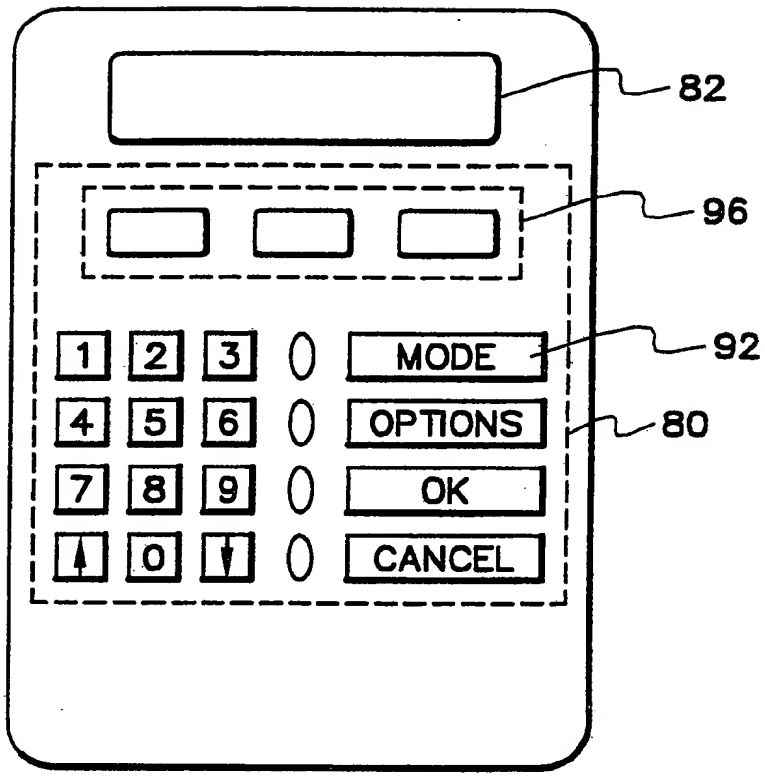
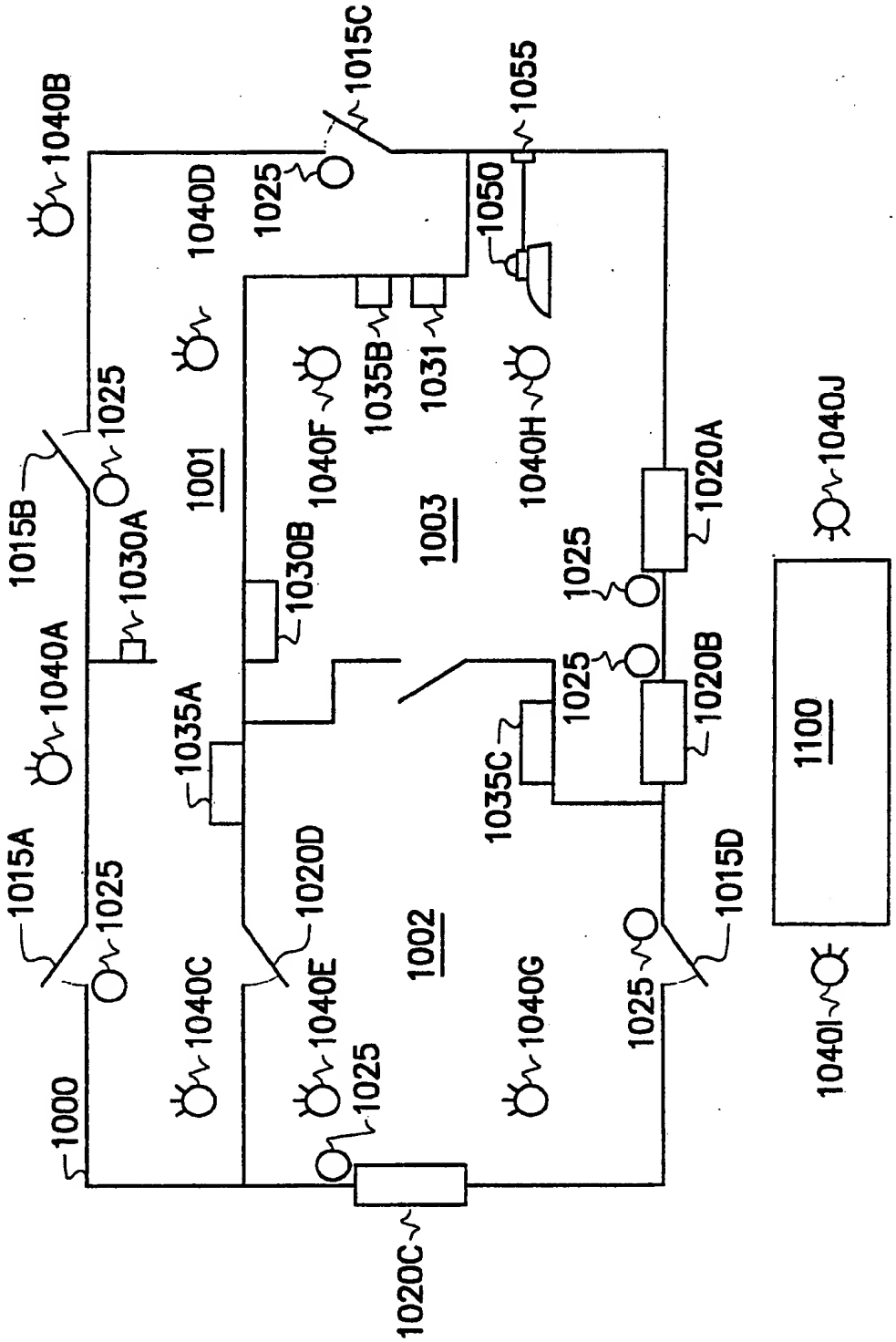


Fig. 4


1040B
1015C
1055
1040D
1025
1050
1035B
1031
1040F
1040H
1025
1030A
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1015B
1030B
1040A
1035A
1025
1020B
1100
1040J
1035C
1015A
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1025
1015D
1000
1025
1020C
1040I

Fig.6

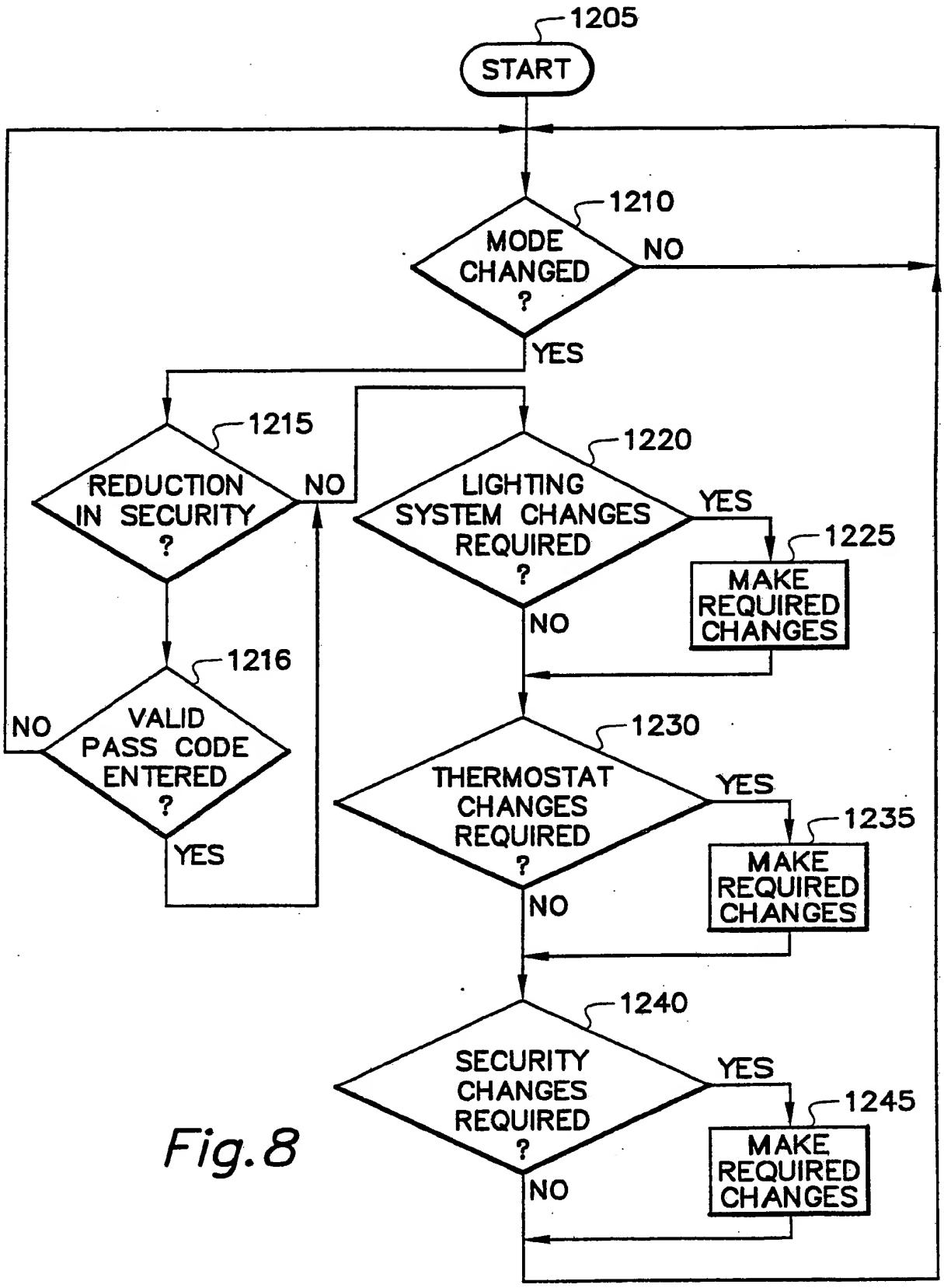
1205
START
1210
MODE CHANGED ?
NO
YES
1215
REDUCTION IN SECURITY ?
NO
1216
NO
VALID PASS CODE ENTERED ?
YES
1220
LIGHTING SYSTEM CHANGES REQUIRED ?
YES
1225
MAKE REQUIRED CHANGES
NO
1230
THERMOSTAT CHANGES REQUIRED ?
YES
1235
MAKE REQUIRED CHANGES
NO
1240
SECURITY CHANGES REQUIRED ?
YES
1245
MAKE REQUIRED CHANGES
NO

Fig.8

III. DOCUMENTS CONSIDERED TO BE RELEVANT (CONTINUED FROM THE SECOND SHEET)

Category °	Citation of Document, with indication, where appropriate, of the relevant passages	Relevant to Claim No.
A	NEC RESEARCH AND DEVELOPMENT no. 97, April 1990, TOKYO JP pages 57 - 65 S. TSUMURA ET AL. 'A HIGH PERFORMANCE POWER LINE SPREAD-SPECTRUM MODEM' see page 63, paragraph 6 - page 65, paragraph 7; figures 10,11	1-9, 11-14, 17-20
A	IEEE TRANSACTIONS ON CONSUMER ELECTRONICS vol. 32, no. 3, August 1986, NEW YORK US pages 558 - 565 K. IIDA ET AL. 'HOUSEKEEPING APPLICATION WITH BUS LINE AND TELECOMMUNICATION' see the whole document	1-20